THE ACTION OF LIGHT

AS A

THERAPEUTIC AGENT

BY

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MOTTO:

"Lux vos Liberabit."

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BALTIMORE, MD.

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THE Trustees of the Fiske Fund, at the annual meeting of the Rhode Island Medical Society, held at Providence, June 2, 1904, announced that they had awarded a premium of two hundred and fifty dollars to an essay on "The Action of Light as a Therapeutic Agent," bearing the motto:

"Lux vos Liberabit."

The author was found to be LEONARD K. HIRSHBERG, M. D., of Baltimore, Md.

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SYNOPSIS.

THE ACTION OF LIGHT AS A THERAPEUTIC AGENT.

(*Lux vos Liberabit.*)

Although Hippocrates mentions sunlight as an important means of treating certain affections, and Herophilus of torcular fame gives a word or two concerning the effects of light upon disease, yet it was Erasistratus, famous for healing Antiochus of a secret ailment (which was no more than a feverish love-affair with his step-mother, Stratonice), who first emphasized sunlight, exercise, and baths before all other therapeutic measures. His death occurred about 280 B. C.

Cornelius Celsus, a reverent follower of Hippocrates, naturally enough suggested fresh air and light as remedies. Galen, persuaded in a dream by Apollo to undertake the study of medicine, mentions the importance of light in conjunction with other measures as a treatment for chronic diseases.

Of the Arabic school Rhazes was the first to speak of light as a help in disease. He died 932 A. D. Avicenna, who followed him in the eleventh century, and Albucasis in the twelfth, touch but slightly upon light as a therapeutic measure.

John of Milan, in his famous poem *Regimen Sanitatis Salerni*, written for Robert of Normandy (which passed through two hundred and eighty editions), wrote passages advising against the "avoidance of light," and always "to shun noonday slumbers."

John Gaddesden, whose volume, *Rosa Anglica*, was

made up of superstition, charlatanry and mysticism, also indicates that he held bright light, both artificial and natural, at least to have a suggestive value upon his patients. His book appeared in 1310 and first proposed a cure for scrofula by the king "laying on hands." Hence the name of "king's evil." Guy de Chaubác, quoting the Greek, Latin and Arabic physicians, in his *Inventory* of 1363, included sunlight in his therapeutics.

Thomas Linacre of Canterbury, founder of the College of London in 1500, Jacobus Sylvius, Andreas Vesalius, Ambroise Paré, Astru, and others of the same period, make no mention of light in their writings. With the advent, however, of the scientific physicians of the seventeenth century, just as the simple microscrope was coming into use, Hooke (about 1667) invented the term "cell," destined to play such a significant part in modern medicine. Maphighi a few years later evolved the distinct cell doctrine. At the same time, Copernicus and Kepler revolutionized man's ideas of the heavenly bodies, and a truly scientific attitude was directed towards the study of light and its effects. In 1642 Galileo was martyred for discovering the motion of Jupiter, and inventing the thermometer and telescope. In 1665 Sir Isaac Newton promulgated the laws of gravitation, and ten years later Rïmer calculated the velocity of light, while Huygens discovered the polarization of light. All knowledge was being analyzed into its simplest and truest terms. It was but natural, therefore, living in such an atmosphere of science and simplicity that Thomas Sydenham, the real father of modern medicine, should advocate more simple methods for treating disease, insisting

upon the "healing power of nature," as he called light, rest, fresh air and water.

It was not, however, until bacteria and their relation to disease became known, that the treatment of disease by light was really put to a scientific test. Dounes and Blunt in 1877 proved that the continuous and vigorous application of light was fatal to many microorganisms. William Koch showed that the growths of others were either killed or inhibited when exposed to sunlight. Ten years later Von Sachs showed the effects of light on various plants and lower organisms, and Loeb in 1890 demonstrated that certain lower forms of life when exposed to blue and violet light arranged themselves parallel with and moved in the direction of the rays of light, such as fly larvae, caterpillars, hydroids and beetle larvae; even when their heads and brains were removed, showing the effects of real actinic powers of light on muscular tissue. Many other organisms moved away from the rays. Loeb, therefore, made a division of light into positive and negative heliotropism.

In 1893 Benedict Friedlander proved by careful controls that the pigmentation and dermatitis produced by sunlight and the arc electric light is brought about exclusively by the blue-violet rays. He was the first to suggest that the arc-lamp had therapeutic properties, a suggestion which Finsen quickly investigated and proved in a practical manner. Unna, Widmark, Hammer, Charcot and Wilde, all contributed to the proof that the dermatitis and pigmentation produced by the sun were due to the chemical (ultra-violet) portion of the spectrum.

Although John of Gaddesden, as part of his charla-

tanry, treated smallpox with red shades, red curtains and red paper windows, it was really Dr. Trudeau of our own land who first employed light in any elaborate and methodical manner for the treatment of disease. At his Saranac Cottage Sanitarium for more than thirty years, patients suffering with tuberculosis have been subjected to daily sun baths, without the interposition of any glass. Where glass-enclosed sun parlors are employed to obtain sun baths, little real value is obtained from the treatment, because many of the ultra-violet rays are cut off by glass. The treatment is, therefore, imperfect, and good results cannot be expected.

Energy from the sun reaches the earth in the form of waves, according to the prevailing theory of light. These waves vary both in length and velocity. The longest waves are quite invisible, and unappreciable by our special senses. These are known to us as heat rays. Shorter waves stimulate the retina and visual organs and are spoken of as light. The shortest waves produce chemical changes, for example reducing silver salts; they are called actinic rays.

Under most natural conditions all of these are mingled as white light, but they can be decomposed and differentiated by a prism. Each wave-length appears then with its own special color, but only the coarser colors are recognized by us, such as red, orange, yellow, green, blue, and violet.

The shortest waves are beyond the violet end of the spectrum, but are not classified as light. The principal characteristic of these waves are their power of inducing actinic or chemical changes, exciting fluorescence and phosphorescence.

The sun's energy may, therefore, be divided into calorific, luminous and actinic rays, according as we pass through the infra-red portion of the spectrum, the visible portion, and reach its ultra-violet part. Although sunlight is really richer in ultra-violet rays than an arc lamp with carbon electrodes, most of it is filtered out by the atmosphere. Therefore the arc lamp produces more.

Ultra-violet or actinic rays impress themselves but slightly upon the retina. They produce most remarkable changes, however, in living tissues. When permitted to fall upon mixtures of hydrogen and chlorine an explosion will occur. Solutions of quinine, resoniline, eosin, kerosine oil and other compounds become fluorescent when exposed to them. By writing with solutions of quinine or kerosene oil upon note paper, the entire script will immediately become visible if exposed to these radiations.

The dermatitis of sunburn can be produced artificially by ultra-violet rays. Pigmentation, erythema, eczematoid, bullous and other skin eruptions have all been produced by actinic rays. Bacilli of tetanus and gaseous phlegmon are more rapidly killed by exposure to them than to bichloride of mercury. The first suggestion to use the ultraviolet radiations, especially from arc lamps, for therapeutic purposes, was made in 1893 by Benedict Friedlander. As before mentioned, however, it was already in vogue by Trudeau, empiracally. The latter gave his patients sun baths by exposing them in a reclining position for from three to sixty minutes daily. The exposure was increased every day, but owing to the more rapid effects, blonds were never exposed as long as brunettes.

At the time Friedenlander suggested the actinic rays as a therapeutic agent, Dr. Niels Finsen of Copenhagen was achieving results worthy of note by treating smallpox with light, filtered through red glass. Without abandoning his experiments in treating smallpox, he began in 1894 to test Friedlander's idea and develop it upon a practical basis. He the more easily seized upon the suggestion, because an old woman came to him and claimed to have been cured of lupus vulgaris by a lens maker of Amsterdam. She told her skeptical listener that the lesions had been burned away by focusing the sun's rays upon the diseased area. Finsen had previously treated the old woman for lupus without results from the usual methods, and now saw her before him with scarcely a scar. He knew her to be quite truthful, and at once added this and Friedlander's experiments together and began the "light" treatment of lupus vulgaris.

Finsen's earliest method was to expose the patient to concentrated sunlight which first passed through perpendicular glass vessels holding a solution of copper sulphate dissolved in ammonia water. The rays of light were concentrated, after they passed through the solution, upon the diseased area by lenses fifteen centimeters in diameter. It was quickly found that the full effects of the ultra-violet rays were only obtained by keeping the blood from the locality to be treated. To this end, an attendant was required to compress the tissues and render them ischaemic. The red haemoglobin when present prevents the chemical rays from entirely passing through and consequently makes the treatment ineffective.

Although there is an effort to revive this, Finsen's

first method, it has almost completely given place to artificial light as a source of the ultra-violet rays. The application of sunlight to the treatment is limited to unclouded days and a few hours of bright days. The particular summer our apparatus was tried in Baltimore there was so little sunlight that this method was abandoned. Other American dermatologists were equally unsuccessful. Finsen himself soon felt the need of a more permanent source of the rays, one which might be applied continuously at any time. He therefore again turned to the laboratory for aid and made a practical trial of the arc electric light.

In the arc lamp, first proposed by Finsen, a system of condensers carried the rays close to the patient. Only one patient could be treated at a time, and the services of an attendant were constantly required for each patient, to compress the tissues and render the small area, usually about two centimeters, ischaemic. The exposure of the patient lasted about one hour. In a later lamp modeled by Professor Finsen, a short system of condensers is used to bring the source of light very near the surface to be treated. The lenses of the condensers are increased in size and altered in their arrangement. The area treated and the time of exposure is the same, but the number of sittings have been reduced from 129 to 29, and the cost of treatment is reduced fourfold. This lamp is often called the Finsen-Reyn lamp. Dr. Reyn is a brother-in-law of the great activotherapeutist. Twenty amperes of current are necessary in this lamp, which reduces the cost considerably, and were it not for the necessity of an attendant, would place the apparatus within reach of the general practitioner. Jamieson and Piffard first

suggested the use of adrenaline to drive out the blood, render the area ischaemic, and do away with the employment of an attendant.

In an effort to produce a satisfactory, inexpensive, and rapidly adjustable lamp, various lamps have been invented. Many of these are gradually being eliminated entirely, or relegated to their relative positions in producing therapeutic effects. In one class of lamps iron, or the sparks of electric condensers, have been employed as electrodes. In others the electrodes are of carbon, and the amperage thereby reduced considerably.

The best known of the carbon lamps are the Lortet-Gounod lamp, and Dr. Sequeira's London Hospital Lamp. In the latter lamp, which is a modified Lortet-Gounod, the carbons may be brought comfortably within five centimeters of the patient's face, because the heat rays are effectually eliminated by a continuous stream of water circulating between the two quartz lenses. The voltage required is fifty-five and a small amperage of twelve is used. Fifteen minutes exposure gives an amount of reaction supposed to equal Finsen's original lamp. The area treated is also larger and the patient himself produces the necessary local anaemia by pressure against the lens. The economic construction and maintenance of this lamp is equaled by its convenient and rapid application. Recent reports of therapeutic results by employing it have proved disappointing in the clinics of Finsen abroad, and Montgomery and Hyde in this country. Superficial lesions are improved by applications with this lamp, deep nodules are uninfluenced or but slightly altered. The lamp devised by Dr. Sophus Bang, made with iron

electrodes, is no longer used in Finsen's institute. The requisite amount of reaction was produced by four minute exposures, but it influenced only the most superficial lesions.

Finsen attributes the failure of many of these lamps to the fact that the outer layers of epidermis absorb the ultraviolet rays before they can affect the deeper strata. The condenser spark, which is richer than either carbon or iron electrodes in actinic rays, was utilized by Dr. Goerl of Nüremberg in the manufacture of a lamp. The same objection, however, holds for this lamp; it is beneficial only for superficial conditions. The most recently devised lamp, made by direction of Dr. Henry G. Pifford of New York, has iron terminals. By permitting air ventilation, water tubes are dispensed with. Six amperes and 110 volts are used. It is ostensibly a hand lamp, and together with the rheostat weighs only eight pounds. Its efficiency has not yet been sufficiently tested to admit of an authoritative opinion. Nevertheless, from the low amperage and small amount of radiations, little need be expected from its use, except in the case of most superficial affections.

The outfit now employed in Finsen's institute, which has stood the test of eight or nine years clinical and experimental observation, is the large arc-lamp with carbon electrodes. It employes an amperage equivalent to more than ten horse-power. Four telescope-like tubes furnished with quartz lenses about twenty-five centimeters in diameter are present in the chambers between which water is constantly circulating. An additional set of quartz compressors are used to squeeze the blood from the part toward which the rays

are directed. "Whenever quartz shall be replaced by a material from which a larger lens may be made, larger areas may be treated at one time." (Montgomery.) A new form of glass is used in a lamp recently manufactured and called the "Actinolite." It is claimed that this material permits the free passage of ultraviolet rays.

Experiments by Finsen and Jansen as to the average penetrating powers of the following lamps were performed upon an ischaemic rabbit's ear, on the outside of which was placed sensitized paper.

α Finsen Lamp. 70 Amperes and 55 Volts.

One rabbit ear required one second exposure.
Two rabbit ears required 5 to 6 seconds exposure.
Three rabbit ears required 20 to 22 seconds exposure.
Four rabbit ears required 120 to 150 seconds exposure.

β Finsen-Reyn Lamp. 20 Amperes, 55 Volts.

One rabbit ear required 1 second exposure.
Two rabbit ears required 6-7 seconds exposure.
Three rabbit ears required 20-22 seconds exposure.
Four rabbit ears required 120 to 150 seconds exposure.

γ Lortet-Gounod Lamp. 15 Amperes and 50 Volts.

One rabbit ear required 1 second exposure.
Two rabbit ears required 20 to 25 seconds exposure.
Three rabbit ears required 4 to five minutes exposure.
Four rabbit ears, negative. Would not penetrate.

δε Bang Lamp. 8 Amperes and 35 Volts.

One rabbit ear required 1 minute.
Two rabbit ears required 5 minutes.
Three rabbit ears, no penetration.
Four rabbit ears, no penetration.

The employment of sunlight in place of the arc light is at present again receiving the attention of

authorities in phototherapy. As above mentioned it has conspicuous limitations. On the other hand, the apparatus necessary is inexpensive and simple. In the arc light the rays diverge from a point, hence the desirability of a close approach of the patient to the lens. Expense also greatly limits the size of the lens.

On the other hand in sunlight, the rays are practically parallel and the amount of light is limited only by the size of the lens. At least some ultraviolet rays pass through all glass. It is therefore quite possible to make the sunlight collecting lens of ordinary glass so large that it will compensate for its deficiency in permeating powers. It will thus be equal in actinic power to a smaller rock crystal lens. Although practical photographers believe the contrary, the arc lamp contains more actinic powers than does sunlight. This is due to absorption by the atmosphere, as previously explained.

It has been shown experimentally that if all conditions are the same as regards amperage, voltage, and condensers; in two given lamps, one with carbon and the other with iron electrodes, it took the lamp with iron electrodes three times as long to penetrate a given tissue as it did the lamp with carbon electrodes. This was demonstrated by Bang. Kromayer suggested and Busck proved that the iron electrodes give a light with few blue, violet, or ultraviolet rays of longer wave length. Therefore, they cannot produce the penetration of carbon electrodes.

The proof that ultraviolet and violet rays are the true bacteriacidal portions of light can easily be given, by filtering them out with a quinine solution. Streptococci, staphlococci, typhoid bacilli, anthrax, tuber-

culi bacilli and various other species have all been killed in this manner. At the same time it can be proved in this way that the outer invisible rays have less influence on germ life than the visible ultraviolet rays. It has similarly been proved that the effective parts of the spectrum in the treatment of cutaneous affections are the visible blue and ultraviolet rays with the intervening parts.

The reaction which the human skin manifests when exposed to these rays is variable according to whether the skin is in a normal or pathological condition. The earliest change begins in normal skin with an inflammatory condition. The endothelial cells in the internal of the blood vessels swell and then proliferate. Cells which have undergone alteration from a pathological cause, at first show regressive changes and then disappear entirely. Unchanged connective tissue-cells are stimulated and show progressive activity. The cells which have only begun to be influenced by the pathological process are rapidly restored to a healthy condition. Coagulative necroses never occurs, distinguishing the reaction thus from cauterization. Destruction of normal tissue is absent, while diseased cells are removed and give place to cicatricial tissue. This latter is so evenly distributed and the normal tissue so completely preserved that the scars which remain are often almost invisible. That the real action of light depends upon the stimulation of superficial circulation and the cellular alterations which follow, seems to be indicated by the dilatation of the blood vessels and the hyperaemia which sometimes remains for months after a vigorous reaction has been produced. Yet in addition, a bacteriacidal and an electrical effect also seems

to be present. In patients with pigmented skin, thick scar tissue, or deep-seated nodules, ultraviolet rays are not of much value. These cases require treatment of another sort, and it is just such lesions that make the X-rays so valuable.

In the year 1895 Dr. William Conrad Roentgen announced to the world his discovery of a form of radiant energy which could be passed through various opaque bodies, including living forms, and make them transparent. He called this manifestation of energy a ray because of the regular shadow it throws upon a screen. The usual algebraic symbol x signifies the inexplainable phenomenon of this radiation. X-rays emanate from the cathode end of a Crookes' tube, but they are by no means identical with cathode rays. Cathode rays are usually understood to consist of molecules of residual gas in the Crookes' tube which is always an incomplete vacuum. These molecules are electrified towards the cathode, then repulsed by it. They travel at a velocity dependent upon the potential of the cathode. This is about one-twentieth that of sunlight. This is a relative estimate, because the distance a molecule can travel in a tube without impinging upon another molecule, depends upon the degree of exhaustion present, i. e., the amount of residual gas.

Roentgen-rays are generated at the glass wall of the discharge apparatus at the point where the cathode rays strike and fluoresce most decidedly. Any substance placed within the tube at this spot is thus a source of X-rays. They arise where the cathode rays strike, even if the substance be a real anode. X-rays differ from ordinary light by being absorbed by glass

and other crystalline substances. Some bodies opaque to sunlight are transparent to the X-rays just as other substances transparent to daylight are opaque to these rays. X-rays produce fluorescence and phosphorescence, and penetrate opaque bodies, usually in direct proportion to their density and thickness. Skin, cartilage and the softer human tissues are penetrated by them, bone casts a light shadow, most metals are not penetrated.

Three forms of apparatus may be used to produce X-rays. The Rumskorff or induction coil, the Tesla or high frequency current, and the static machine. Except the static machine it is necessary in producing the X-rays to have batteries, a current of some kind or a lighting circuit.

The tubes which are usually used are modifications of the high vacuum tubes first devised by Sir William Crookes. Into each end of these are soldered solid platinum terminals. At the anode where it enters, the current is positive; at the cathode where it leaves, it is negative. When the excitation is started, if the vacuum is not too high, fluorescence will appear within the tube. If at any time the platinum anode becomes red or white hot, it is considered by Schmidt as evidence of a leakage of the current or of a very low vacuum tube.

Shortly after the discovery by Roentgen it was noticed that in making radiographs, irritation of the skin was often produced. Then reports were published of cases of true dermatitis, erythema, blisters, and even sloughing. The next step was but a natural one; it suggested itself first to Freund and Schiff in 1898. These two applied the X-rays to the treatment of many

conditions and in their original paper were able to classify the diseases which were best improved by the method employed.

In one of his most recent publications Schiff suggests that there should be two methods of treatment, one to be applied by beginners, the other by the more experienced. This, according to Schmidt of Chicago, is evidence of the difficulty of application of the x-rays in a uniform manner. The best method in general use at present is to employ a current of 12 volts and about 1.5 amperes. The spark gap should not exceed 30 cm. with probably 1,000 interruptions per minute. To measure the amount of energy going through an active tube, it is necessary to state the number of volts and amperes passing through the primary coils. This, however, does not measure the amount of energy at the terminals of the secondary coil. The latter depends upon the design of the induction coil. One make of coil will produce, with 12 volts and 1.5 amperes going through the primary, a 20 cm. spark, while another with same amperage and voltage will only yield a 5 cm. spark.

This may depend upon (1) the number of ampere turns of the primary to that of the secondary windings; (2) upon the amount of air space or gap; (3) upon the insulation between the primary and secondary and upon the insulation of both coils; (4) upon the primary iron core, thickness, length, number of wires, quality of the iron (magnet); (5) upon the number of turns and thickness of the secondary coil; (6) and lastly upon the method of interruption of the primary current, made perfect or broken sharply and so forth. We are, therefore, as little able to measure the actual

energy between the terminals of the secondary as to state correctly the energy of a static machine by the amount of current passing through the electric motor which drives its revolving plates.

Schmidt's method for measuring the tube strength is probably the best. It is both simple and inexpensive, and may be applied to any source of X-rays. It consists in introducing a separate "shunt" parallel to the X-ray tube by means of two sliding contact points. The points are brought within such a distance of each other that the energy passes between the points of the shunt-spark gap. The electric energy is thus measured in centimeters according to the amount consumed by a given tube. In conjunction with a tube of definite size and the distance of the terminals and its degree of vacuum, quite accurate measurement of its power is given. The fluoroscope should always be used at the same time as corroborative. Schmidt's method is simple and accurate, and by employing it the excess of energy, which might pass through and around the tube and limit the production of X-rays by too many heat rays and sparking at the terminals, is entirely avoided.

The vacuum in some tubes can be regulated, at times automatically; in others there is no way of arranging the vacuum. The Gundelach tubes can be regulated, and the Mueller tube is also automatic. The tubes which are not adjustable are rapidly disappearing from general use. Roentgen first divided tubes into hard and soft, the former being a more complete vacuum than the latter. When tubes are too hard, no light or X-rays appear; when too soft a large quantity of X-rays will pass, but they will not penetrate. In cases where

there is comparatively no vacuum all of the energy is converted into heat and no X-rays are produced.

With Schmidt's method the higher the vacuum the greater is the spark, but a large amount of fluorescence does not necessarily mean a large quantity of X-rays. This means, as a rule, a low vacuum, or depends upon a deposit of aluminum on the inner wall of the tube, as is found in old tubes. Irregularities, manifested as bright areas, denote a tube of high vacuum. Suitable x-rays for therapeutic purposes can best be produced from tubes of medium vacuum. Long usage and excessive currents alter the fluorescence of tubes very markedly. If a high vacuum tube and a 35 cm. spark is passed, the very greatest quantity of X-rays is generated. In a low vacuum tube, the same spark is converted into heat which ruins the anodal plate and still further reduces the vacuum.

Flat intratubal plates are more advantageous when in use than rounded ones. The intensity of X-rays and the chance of causing burns varies directly as the time during which it is applied, and inversely as the distance between the anode and the skin. The angle of incidence equals the angle of refraction, that is the rays are thrown at right angles with respect to the anodal plates. The distance of the tube from the skin varies according to its strength; the nearer the tube to the skin the more rapid and intense will be the reaction. The distance from the *focus* of the anode with a medium sized Mueller tube is from five to fifty-five centimeters. The shape, size, quality of vacuum and spark length must always be considered.

The clinical results of the X-rays is the same in all successful cases; decrease of pain, drying of any dis-

charge, smoothing of rough surfaces, and production of sear tissue. At times tumors are softened and usually diminished in size. Over exposure or idiosyncracy produces what is known in the normal skin as an X-ray burn, most common in radiographers who are also doing photographic work and therefore constantly coming in contact with chemicals.

Many radiographers and clinicians are divided upon the nature of the tissue changes which are produced by x-rays. Speculation, histological studies, and clinical results all play their share in these explanations. The findings of others are substantially verified by my own investigations of this matter which are here submitted for the first time.

In experimental animals, the X-rays cause a hypertrophy in the stratum granulosum which becomes many times thicker than normal. The cells are not altered but sebaceous glands, nerve fibers, hair follicles, and buds were entirely absent. Connective and elastic tissue of the dermis is unaltered. The intima in the veins and arterioles shows some apparent thickening and a decrease in their lumen. The trophic nerves of the part may become electrified in X-ray dermatitis as suggested by some, but there is nothing to show this histologically.

With the assistance of two of our medical students, Mr. Parks and Mr. T. W. Law, I exposed cultures of spirillum cholerae Asiaticae, B. typhosus, B. anthracis, B. diphtheriae, B. pyocyaneus, streptococci, staphylococci, and B. dysenteriae Shiga to X-rays for ten, twenty, thirty, forty minutes and one hour for ten successive exposures. The cultures were planted upon blood serum agar, plain agar, and in beef tea. The

growths were successfully transplanted after each exposure with the exception of the green pus and Asiatic cholera organism, each of which failed to grow twice. The organism of Asiatic cholera was killed after an exposure of twenty minutes and forty minutes respectively, but continued to grow after longer exposures. The green pus bacillus gave the same results, suggesting some faulty technique and not death by X-rays. Therefore I have concluded that these rays are not bacteriacidal.

The material upon which my histological findings are based was obtained from many surgical friends at the Baltimore City Hospital and the medical school. Tissues were fixed and hardened in formalin and Mueller's fluid and stained by Weigert's method, eosin and haematoxylin, and Ehrlich's triple stain. Marchi's osmic acid impregnation was used also for the nerve sheaths.

Tissues which were subjected to long and repeated exposure to X-rays and which had become secondarily infected with streptococci, staphylococci and bacilli, never exhibited any diminution in the activity or numbers of the micro-organisms present. This is in confirmation of my other experiments with cultures. In an example of a squamous celled epithelioma subjected to ten, fifteen minute exposures with three day intervals, there was considerable necrosis of cells and pearls, evidence of fatty degeneration and increase of elastic tissue. The clinical results were the usual ones in cases which improve; relief of pain, decrease in the discharge and formation of cicatricial changes.

Another specimen of epithelioma which had been exposed twenty times for ten minutes with two day

intervals showed vacuolated cells with swollen vesicular nuclei, deposits about the intima of the blood vessels, and great numbers of lymphocytes and bacteria. No polymorphonuclear leucocytes were present.

An example of lupus vulgaris and a portion of the skin beyond the area diseased had been exposed twenty times to fifteen minute treatment every other day. Much the same microscopic picture was obtained as in the skin of guinea pigs under similar circumstances. Sweat glands, muscle fibers of hairs, hair follicles, and elastic tissue were disintegrating, disappearing and making way for fibrous changes which were crowding in from above.

Epidermal changes following the disappearance of patches of eczema and acne under treatment, show the formation of new epithelial cells between irregular patches of scar tissue, often only perceptible beneath the microscope.

To the naked eye after fifteen minutes exposures, the cutaneous surface will show in from one day to a week or more, hyperaemia, swelling (anaesthesia or a feeling of formication or numbness is present), and looseness of the hairs in the part. Pigmentation occurs in some cases, dermatitis, blisters or sloughing in others. Such effects may appear from one prolonged exposure or many shorter ones. Idiosyncrasy plays a considerable part, but the results may be modified by (a) strength of the current, (b) distance of the tube, (c) quality of the vacuum, (d) condition of the skin.

The conditions most benefited by X-rays are those represented by diseased hair follicles, where the hair is loosened, such as favus, sycosis and seborrhea. Another class of cases which are improved are those

exhibiting cell proliferation, such as lupus and carcinomata superficiale. Low and anomalous cell types are profoundly influenced by the rays, and the production of connective tissue is promoted.

So far as tissue reaction is concerned X-rays are much more powerful than the rays from the violet end of the spectrum of the electric arc. Its action, however, is less defined than the latter, longer in appearing and has less uniformity in the quality of the light. Many cases of lupus erythematosus and lupus vulgaris which remain stationary with X-ray treatment are among the first to recover with the Finsen light. It is not necessary to dilate upon the protection of the unexposed parts of the skin. Thick sheet-lead which is easily moulded and lined with flannel, is most serviceable. The lips and hair of the head must be especially protected from effects of the rays.

The conclusions to be drawn from the results of treatment in a great number and variety of cases both by the ultraviolet and X-rays will be summarized at the conclusion of this paper.

In 1896, M. Henri Becquerel, the distinguished French chemist and physicist, found that when uranium was exposed to the sun's rays, it apparently had the power of absorbing them and produce a change in a photographic plate. From this fact he quickly reasoned that the ore from which uranium came might yield the same result. He, therefore, took a specimen of pitchblende, an object, and a photographic plate with the intention of exposing them to the sun's rays. That particular day was cloudy, so the photographic plate with its dark wrapper was laid away and the key with the pitchblende was placed upon it. On taking

up the specimen later, he was much astonished to see that the pitchblende had really printed an image of the key upon the plate. M. Becquerel had evidently discovered some extraordinary properties of an unknown substance. Whereas he had supposed the photographic action of uranium to be due to the absorption and emission of sunlight, he now concluded that the new substance could of itself produce images of a photographic nature in the dark by what were named "Becquerel rays."

Pitchblende is a complex mineral containing not less than ten elements that require great skill and ingenuity to separate, and traces of many others. Uranium compounds compose three-fourths of it, the residual fourth contains all the other elements, and the new radio-active elements. At the Austrian government works near Joachimsthal, Bohemia, uranium has been prepared for many years. Tons of the residual material lie there and have hitherto been considered useless.

Madame Curie, a native of Poland, who had been a student of chemistry before she married Prof. Pierre Curie of Paris, took up the study shortly after Becquerel announced his discovery. Her remarkable enthusiasm and assiduous zeal for investigation induced her husband to assist her. They noticed at once that the residual pitchblende produced much more radioactivity than uranium and its compounds; so they undertook to separate the unknown body. In 1900 Madame Curie announced the discovery of the two new elements which give forth most of the radio-activity of pitchblende. Polenium, she called one, after her native land, and the other named radium from the Latin. Thorium, which was known before, was also

found to have radio-active properties. Actinium has since been discovered by one of M. Curie's assistants, and is also radio-active.

The facts that sulphide of lime can print photographs through paper not affected by light, and the blue and green phosphorescence of the same mineral in a glass tube can penetrate through aluminum and act on a photographic plate were discovered by Becquerel before he found that uranium rays could penetrate solid bodies. Then followed the discoveries of the Curies.

Radium activity is the strongest of these radio-active elements. It will pass through several books and four inches of solid plank wood, and induce phosphorescence in a diamond beneath them.

The standard of radio-activity existing in uranium is taken as one and the most concentrated radium so far obtained has an activity of 1,800,000. It is measured in various ways. Curie's method depends upon the fact that these emanations render the air and other gases through which they pass conductive to electric charges. A layer of radium is placed on a horizontal plate condenser. The upper plate of the condenser is connected with an electrometer and the ground, thus making the potential normal with the ground. The lower plate is raised to a high potential by means of a battery, and as the intervening air is rendered conductive by the radio-active substance, a current is produced between the plates. The ground connection of the upper plate is now broken, the plate becomes charged and the electrometer is deflected slowly or rapidly according to the strength of the current which is thus measured.

Pure radium has probably not yet been obtained. One pound of it would probably blind, or even kill all human life exposed within several yards of it. A minute quantity of high intensity carried in Professor Curie's pocket produced an ulceration upon the underlying tissues that took nearly two months to heal.

There are three kinds of radio-activity which emanates from radium. These are recognized as *alpha, beta* and *gamma* rays. Alpha rays carry positive electric charges and are easily absorbed by solids. Beta rays are negatively charged and more penetrative than the alpha rays. The gamma rays are even more penetrating, but carry no electric charge at all. The gamma rays are somewhat similar to the x-rays, but are by no means identical. All of these radiations from radium are distinctly molecular emanations from the radio-active element. Professor Becquerel has estimated, however, that the loss of a millionth of a square centimer of radium would require one thousand million years. One gram of radium gives forth ten and one-ninth mil-calories. If the sun were made of radium it could send forth ten and one-ninth calories for every gram without reference to the effects of gravity.

A colorless glass tube in which a few grains of radium of 300,000 activity was placed turned almost black in twenty-six days. Rock-crystal receptacles are necessary to carry radium. Radium has revolutionized physics as much from its radio-active properties as from the fact that it maintains a temperature of from two to three degrees above its environment.

That it is not the luminous property of radium that induces luminosity in other substances is proven by

the radio-active specimens which are not luminous and by the fact that all access of light may be cut off from the object exposed with books, wood, rubber and metals, yet radio-activity will be induced.

Radium penetrates the human tissues with ease. A diamond in the palm of the hand will phosphoresce brilliantly when radium is placed over the back of the hand. Blisters, ulcerations and tissue destruction are produced by radium. Cultures of bacteria were exposed for twenty-four and forty-eight hours beyond a screen which was placed one inch away from ten milligrams of radium and were killed in every case.

The market value of radium keeps it beyond the reach of most of us. The price depends upon its radio-activity. Radium compounds with an activity of 40 are $20 an ounce. An activity of 240 costs $30 an ounce. An activity of 1,800,000, cost Mr. Edward Adams of New York City at the rate of $198,000 an ounce.

Radium changes the color of phosphorus from yellow to red. It produces ozone from the air and when dissolved in water the latter is disintegrated and hydrogen is generated. It gives a violet or brownish tint to glass which disappears if the glass is heated red hot.

Small animals, subjected to radium for a five or six days' exposure, loose their fur, several days later they became blind, and after ten days die. Mice, rabbits, guinea-pigs, chickens and plants are all killed in this way.

Radium as a therapeutic agent is at present in the experimental stage, although after six months' trial of radium as a treatment for malignant disease, the Lon-

don Cancer Hospital has just announced that it would be no longer used there, since no good results were obtained. The results so far obtained from radium as a therapeutic agent do not seem to promise as much as was at first expected. Most of these records are upon superficial growths. In some cases small quantities of radium have been introduced into deeper tissues.

Radium is usually applied through screens of mica, paper, glass, or aluminum. This prevents the alpha rays from reaching the underlying tissues. When the radium salts are spread on paper as a plaster, the alpha, as well as the beta and gamma rays are brought into action. It has been proved that the alpha emanations are gaseous and applicable therefore to pulmonary affections.

It is not yet possible to draw any positive conclusions as to the cure of different diseases in which radium has been applied, from the cases so far recorded. The published cures are only in the experimental stage and are mostly cases of lupus, rodent ulcer, cutaneous affections of other kinds and disease of the palate and lip. Physiologically the effects of radium are hyperaemia, inflammation and ulcers of the skin, paralysis of the nervous system and luminous effects produced in the blind.

Radium rays cannot be used in diagnosis or prognoses. The radiograph and the fluorescent screen do not differentiate the tissues sharply enough, and require the person to be too long exposed to the action of the rays.

Dr. William Rollins of Boston was the first person to suggest radium as a therapeutic agent; it was in

1901. Drs. Goldberg and Londen of St. Petersburg, Professor Gussenbauer of Vienna, Dr. John McIntyre of London, Dr. Darier of Paris, Dr. Mackenzie Davidson of London and Dr. Francis H. Williams of the United States, have since published the most complete accounts of radium treatment.

Radium should be kept in a metallic box with a thin mica covering at the front. A long flexible handle will keep the radium away from the one using it. The strongest action is obtained by placing the box of radium on the part to be treated. A rubber covering will keep it clean and it can be renewed for each patient. A weaker action is obtained by a relatively increased distance from the part to be treated.

Over-exposure will result in a burn which takes days to develop. Exposures must be adapted to the special case. Pure radium bromide in a box described as above will produce effects from the beta and gamma rays on superficial lesions in from one-half to three minutes. Two or three exposures weekly are all that is necessary. The weaker the radio-activity of a given specimen of radium, the longer will exposures be required.

Radium may be applied where other forms of light treatment are not applicable. The exposures are of shorter duration, healing is prompt, and fewer exposures are required. The emanations of radium will impart radio-activity to gases and liquids and these may be applied as inhalations, sprays, locally on external parts, as sprays and douches, for healing purposes.

When radium is dissolved, seventy-five per cent. of its radio-activity is at once liberated; the remainder

consists of alpha particles. The radium in solution is constantly sending forth these emanations and it can be depended upon as a constant source of radio-activity. If a small volume of air which receives the emanations is placed in another gas-holder containing air, the whole volume will immediately become radio-active.

Most of the common metals are radio-active and the therapeutic action of copper and zinc, and especially mercury is attributed to the radio-active gases which have been obtained from them. If a glass tube of radium were placed in the middle of a cancer, before the peripheral parts were affected the neighboring healthy tissue would be destroyed. Tissues within a millimeter of radium would receive twenty-five hundred times as powerful a treatment as those five centimeters away, because its action diminishes with the square of the distance. The continued presence of radium would prevent the formation of fresh granulating tissue in the interior.

If radium is placed ten centimeters from the skin, the intensity at a depth of one centimeter is as great as the intensity at the surface from X-rays. The sound tissues beneath the diseased will be influenced nearly as much as the place affected. It is therefore necessary in treating a skin disease with radium to bear in mind to what depth the radio-activity should be confined.

Thorium, one of the rarer elements, was discovered by Berzelius in 1828. It is found in Norway, Sweden, North Carolina and Brazil. Ten years ago it was adopted as the principal constituent of the Welsbach incandescent mantle. The Curies and on this conti-

nent Professor Ernest Rutherford of McGill and G. C. Schmidt first called attention to its radio-activity. This can be shown by means of an electroscope or a sensitized photographic plate, just as we test radium. By dusting upon a photographic plate the remains of several Welsbach burners (rich in thorium oxide), and placing a watch, chain, or other objects upon the plate, a fairly good negative (thoriograph) will be obtained in seventy-two hours. If a photographic plate upon which several objects are placed be exposed to the hot emanations of thorium oxide, a thoriograph may be obtained in an hour.

It has been shown that thorium radiations will prevent fermentation in grape juice, juniper and erigeren oils, even when open in a warm room for several weeks. The emanations of thorium inhibit bacteria of a pathogenic type, but do not kill them.

Thorium is active in powder form, as a paste or ointment, as a gas or in solution. By heating the oxide in a glass receptacle or making a solution of thorium nitrate, it may be used as an inhalation. Dr. Soddy of London and Dr. Rutherford of Montreal have suggested these inhalations for pulmonary conditions, but no authoritative results have yet been obtained.

The radio-activity of thorium, like its price, is many times less than radium. It is seven dollars a pound. Owing to its weakness it must be used longer and more frequently in treating diseases than more radio-active substances. Inhalations of thorium radiations leave in the lungs a thin film of radio-active substance which induces radio-activity in the alveolar epithelium which lasts for one or two days after ces-

sation of the inhalation. This is easily proved by allowing the patient to breath in a dark room upon a photographic plate. Treatment should be given every other day for a period of fifteen minutes increased later to half an hour. The receptacle containing the thorium oxide solution is heated over a sand bath to a temperature of 300° F.

A. Charpentier read a paper before the Paris Académie des Sciences, December 14th, 1903, which proves that phosphorescent and fluorescent bodies become more luminous when in proximity to a functioning muscle or nerve. He was studying the Blendlot or N-rays and found that it was possible to trace the course of a functioning nerve by the greater luminosity of the fluorescent screen over it.

N-rays are detected by enclosing a gas jet in a metal box impermeable to heat and light rays. The box contains a window of aluminum which also arrests the heat and light rays, but allows these N-rays to pass. If they are focused by an aluminum lens after they have traversed the aluminum window, it will be found that an electric light or a scarcely visible gas flame will shine more brightly under their influence, while phosphorescent or fluorescent bodies become more luminous and active.

Aluminum and paper transmit the N-rays, and filter out the light and heat rays. N-rays are arrested by lead. Their wave length is far below that of heat, and above that of electricity.

In Charpentier's experiments the increase in luminosity was apparent even through intervening substances, except those impermeable for the N-rays. The rays thus emitted by the human organism reflect

and refract like the N-rays and are equally pronounced even after the patient has been in complete darkness for nine hours. This proves that the rays are actually emitted and not merely the effects of stored-up light in the tissues. He was able to determine the outline of the heart by changes in the luminosity of a small fluorescent object held over the parts. At the present writing no therapeutic tests have so far been published from the results of N-rays.

In February, 1904, Charpentier published further experiments with the N-rays and announced that they are transmitted by metallic bodies and by wire. The visual sense is made more acute by holding a steel plate or copper transmitter covered with phosphorescent sulphide against the head in a dimly lighted room. The N-rays emanate from the steel plate and the maximum effect is obtained by holding it over the angular gyrus. He has found on his own person that luminous sensations are produced in the dark by the N-rays. He also observed that the pupil reacts differently, according as the rays are directed upon the quadrigemina or the ciliospinal center at the seventh cervical vertebra.

Another test of the N-rays recently made in London is to use a fluorescent screen of very thin celluloid coated with calcium or zinc sulphide in the center, so thin that print can be read through it. This screen becomes fluorescent by being held near a source of ultra-violet rays and this fluorescence is then allowed to die away until it has reached the steady stage.

If a contracting muscle is now held under the screen its light will be seen to become markedly brighter. A most convincing test is to place a feebly fluorescing

screen on the floor beside a bare foot in a dark room. The screen cannot be seen until the toes and foot are worked, when the screen at once glows out brilliantly before the eyes of the standing person.

Early in the present year another means of employing fluorescent substances for therapeutic purposes was reported by Von Tappeiner. He announced that certain bodies, themselves not at all bacteriacidal, become extremely so when fluoresence is induced in them by sunlight or diffuse daylight.

Additional research has shown that this action is effectual also upon toxines and enzymes. Ricin, abrin, and robin lose their property of agglutinating red corpuscles after exposure to this fluorescence. Various bodies were tested, and eosin was found to have the most vigorous action upon living cells, enzymes, and toxines. It was then given therapeutic trials. Superficial lesions were painted with a five per cent. aqueous solution of eosin and then exposed to sunlight.

Three cases of carcinomata, ten cases of condylomata lata, five of lupus vulgaris and several of other cutaneous diseases were thus treated. In one case of destructive carcinoma of the nose and cheek on a woman of seventy-six, after four weeks of daily treatment, the edges of the lesion subsided, the suspicious zone of infiltration around it completely vanished, the interior of the cavity showed fresh, healthy granulations and a strip of healthy cicatricial tissue eight to thirteen millimeters extended through a part of the growth. A rodent ulcer of eighteen years standing cleared up under six weeks' treatment to a healty granulating surface with nothing to suggest the pre-

vious condition. The third case of cancer after sixty days' treatment, has a smooth ciatrix in the place of the former succulent proliferating carcinomatous growth. The superficial lupus cases healed rapidly, but those in which the nodules were deep-seated, were not benefited.

Sound tissue is not materially affected and in most cases eosin is given simultaneously internally. Condylomata lata of the female genitalia rapidly subsided with local treatment. A primary syphilitic lesion of the tongue also healed and the accompanying glandular enlargement spontaneously subsided.

No further reports have as yet appeared concerning this simple method of treating cutaneous affections by fluorescent substances exposed to sunlight. In 1900 Surgeon Major King of the United States Army, suggested that the effects of quinine upon the plasmodia of malaria, were due to its fluorescent properties, and since Von Tappeiner's experiments, Morton of New York has revived the subject in this country. The entire subject certainly opens up tremendous therapeutic possibilities, which are at present only in the experimental stage. Most of the results so far published must be received with the proper amount of conservatism, for like radium, the application of these properties of fluorescent substances to treatment, probably has a limited action too early to be defined.

According to the reports published within the past few years from the various clinics and light institutes, there are now a sufficient number of cases of cutaneous diseases, lues, and cancer on record as improved or cured by ultra-violet rays or the X-rays, and by radium to draw some conclusions.

The most recent results published in this country obtained from the radium treatment are these of Dr. Francis Williams of Boston. He treated forty-two cases with pure radium bromide at the Boston City Hospital. One case of acne was rapidly healed. In two cases of eczema, two exposures showed no results, but the cases were quickly relieved by X-rays. In two cases of psoriasis, radium was used over small areas which quickly healed, two days after exposure. In four cases of lupus (vulgaris?), parts of each were treated by X-rays and other parts by radium. The latter healed more quickly than the parts treated by X-rays.

In a case of keloids, some treated by X-rays, others by radium, the latter healed much more promptly. Of five cases of rodent ulcer treated by radium, two are healed, and the others show much improvement. One of these latter had not been arrested by X-ray treatment. Twenty-three epidermoid carcinomata not accessible to X-ray treatment show healing in eleven and marked improvement in twelve. Dr. Williams found that the application of radium causes some free discharge over indurated areas, causing them to melt away.

A word may here be mentioned of 400 cases of smallpox which Finsen has treated by excluding all actinic rays of daylight. The best results were obtained by bringing the patients under treatment before the fourth or fifth day of the disease. The chemical rays are excluded by means of red glass which also excludes many of the light rays. The method of controlling the technique is to place photographic plates in the room with the patients, and if, after sev-

eral days, these plates show any reaction, it is evidence of carelessness in the technique of treatment.

Suppuration, secondary infective fevers, and subsequent scarring are all prevented by this treatment and the disease is said to be milder and shorter in its course. Dr. William M. Welch and Dr. Schamberg of Philadelphia, do not agree with Finsen in this treatment. Their reports do not indicate such favorable results after red-light treatment, but Finsen severely criticises the technique employed in this country.

Of fifty-five cases of carcinoma, the majority of which were rodent ulcers, the results of radiotheraphy by Montgomery, Hyde, and Ormsby were uniformly successful. As a rule from twenty to twenty-one treatments were given with moderate tubes until a slight erythema appeared. Treatment was then suspended temporarily, usually two to four weeks.

In a number of cases which were more deep-seated, it was found that while most of the growth had disappeared, a few isolated epithelial pearls required additional treatment. In twenty-five cases there has been no evidence of recurrence in periods of from two to nine months. In cases involving deeper tissue their results were unsatisfactory.

Of seven cases of lupus vulgaris treated by X-rays, four completely recovered and three are much improved. A tubercular ulcer of the hand disappeared completely after eleven treatments. Two cases of disseminated cutaneous tuberculosis and one case of tuberculosis varrucosa cutis were greatly improved.

In nine cases of lupus erythematosus small areas of 2.5 centimeters were treated at a time, and the treat-

ment was followed by hyperaemia in four to eight hours, and dermatitis some hours later. In all but one case much improvement followed the treatment.

Of thirty-two cases of psoriasis treated, all showed a temporary disappearance of the lesions, several remained permanently cured. Nine cases of hypertrichosis, showed removal of the hairs in the area treated after sixteen to twenty exposures. In five cases the hair returned after two months, the other four cases were not seen again.

In four cases of severe acne valgaris the treatment produced marked improvement. Five cases of keloids were slightly improved by X-ray.

Gilchrist reports five cases of cutaneous blastomycosis completely healed by X-rays.

Pfahler's 18 cases of skin cancer were all more or less improved by X-rays in from two to six months' treatment.

Charles W. Allen reports thirty-five cases treated by the X-rays. Fifteen cases were discharged as cured, two are nearly well and one other is improving. Nothing favorable is mentioned concerning the other seventeen cases.

Zeisler reports four cases of sycosis cured, with no relapse after several months. Five cases of acne rosacea, one of acne necrotisans, and twenty-nine cases of acne vulgaris were treated with mild exposures twice a week, distant from 20 to 40 cm. from the tube. Most of the cases were cured in about six weeks' time and the author thinks Roentgen should be blessed for the wonderful results the rays produce in these conditions. He also reports at least temporary recovery in nine cases of epithelioma of the lips, nose, forehead,

glans penis, back of the hand and eyelid. In three cases of psoriasis, only one remained cured after three months. Two cases of lichen planus hypertrophicus were cured completely after four exposures at intervals of five days. Keratosis palmaris, eczema, clavus, and hyperidrosis nasi were each much benefited.

The results obtained from actinotherapy like those from radiotherapy are for the most part observed in the reports of dermatologists. In lupus vulgaris, tuberculosis verrucosa cutis, tubercular ulcers, post-mortem tubercles and all superficial tuberculosis, treatment by ultra-violet rays is firmly established; in fact it is now regarded by some as a test. Lesions which do not improve under it are not tubercular.

Of one thousand cases now treated by Prof. Niels Finsen at his Institute, all of tubercular nature, almost all of them are cured, a few are still under treatment. Of thirty-seven cases treated by Klabowsky more than two-thirds were cured. Of seventy-eight other cases, one-third were permanently cured, one-third are still being treated and will be cured, and another third either ceased to be treated or came spasmodically. Finsen's latest report deals with thirty-one cases of lupus erythematosis. These were incurable with the London Hospital lamp, but with the Finsen lamp there are eleven complete recoveries, nineteen cases are still under treatment. Gottheil reports three perfect cures of lupus erythematosis, and one partially improved. Of Leredde and Pautrier's twenty-three cases, eleven were entirely cured.

Von Ziemsen and Leredde have cured cases of ringworm, favus, sycosis and pityriasis versicolor with Finsen rays, while other authors publish cases of

epitheloima of the skin, Paget's disease and nevi of various kinds, as completely cured.

Frendenthal and Williams find that ultra-violet radiations relieve the symptoms of hay fever almost immediately and pulmonary tuberculosis seems to be favorably influenced when the actinic rays are employed in addition to the usual treatment.

Montgomery, Hyde and Ormsby do not use the X-rays in any scalp disease, owing to the possibilty of producing permanent alopecia by destruction of the hair buds. They treated eighteen cases of alopecia areata by Finsen's rays and obtained complete failure in thirteen cases. Only three exhibited improvement, while there was prompt return of the hair in two. They also record the results obtained by treating twenty-two cases of superficial cancers with ultra-violet rays. Complete recovery was the rule in nearly all cases.

Pusey holds that actinotheraphy is more useful in the treatment of flat nevi and in conditions where it is desirable to produce an inflammatory action without danger. Radiotherapy would cause an uncontrollable reaction, while the former is safe and can be carried to a severe degree with impunity.

In a paper of the character of this one, it would ill become the author in concluding to draw any final deductions with respect to phototherapy in general, or actinotherapy, radiotherapy, or radio-activity in particular. In the diseases in which they are employed, however, it is not going too far afield, I think, to say that for tuberculosis of the skin, at least, phototherapy is the specific. In the case of lupus erythematosus, the results obtained are perfect in a high percentage

of cases. Of all present methods of treating widespread, superficial malignant disease, radiotherapy at least, at this writing, is superior to any other mode of treatment which is not surgical. In conjunction with surgery, it reaches its best results. Surgical intervention is always advisable first, wherever possible; to be followed later by radiotherapy. In inoperable growths, this treatment may improve the condition, but will certainly mitigate the suffering.

Many of the most experienced radiographers believe there is always danger of encouraging an extension of cancer by X-ray treatment, through a dissemination of the carcinomatous cells to the surrounding tissue and thus producing metastases.

In the chronic inflammatory diseases of the skin such as acne vulgaris, rosacea, hypertrichosis, and foci of suppuration, the X-rays are very beneficial.

In lupus erythematosus, actinotherapy produces remarkable results, while radiotherapy is useless. Lupus vulgaris and other tuberculous skin diseases are equally well treated by either method, but ultra-violet treatment while quite as rapid, brings about far better cosmetic effects with less serious results from burns.

The limitations of each of these methods of phototherapy are being gradually worked out and the dangers to the careless operators are now well understood and controllable. Although we cannot yet point out definitely that either is a specific for any one affection, yet each has done more for the curing of certain cutaneous diseases, than any previous method of treatment known.

Lux vos Liberabit.

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Lux vos Liberabit.